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NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT  
(PCT Rule 71.1)

Date of mailing  
(day/month/year)

13.03.2001

Applicant's or agent's file reference  
1571.1144003

IMPORTANT NOTIFICATION

International application No.  
PCT/US00/01362

International filing date (day/month/year)  
20/01/2000

Priority date (day/month/year)  
21/01/1999

Applicant

REFLEXITE CORPORATION

FOREIGN DOCKETING

13 APR 01 - SRU

Update Foreign File Wrapper

ANNUITY DOCKETING

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

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# PATENT COOPERATION TREATY

# PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>1571.1144003</b>	<div style="display: flex; justify-content: space-between;"> <div><b>FOR FURTHER ACTION</b></div> <div>See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)</div> </div>	
International application No. <b>PCT/US00/01362</b>	International filing date (day/month/year) <b>20/01/2000</b>	Priority date (day/month/year) <b>21/01/1999</b>
International Patent Classification (IPC) or national classification and IPC <b>G02B5/124</b>		
Applicant <b>REFLEXITE CORPORATION</b>		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
  
2. This REPORT consists of a total of 13 sheets, including this cover sheet.
 

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 10 sheets.

3. This report contains indications relating to the following items:
 

I    ☒ Basis of the report

II   ☐ Priority

III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

IV   ☐ Lack of unity of invention

V    ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

VI   ☒ Certain documents cited

VII ☒ Certain defects in the international application

VIII ☒ Certain observations on the international application

Date of submission of the demand  <b>26/07/2000</b>	Date of completion of this report  <b>13.03.2001</b>
Name and mailing address of the international preliminary examining authority: <div style="display: flex; align-items: center;"> <div>                     European Patent Office                      D-80298 Munich                      Tel. +49 89 2399 - 0 Tx: 523656 epmu d                      Fax: +49 89 2399 - 4465                 </div> </div>	Authorized officer  <b>Jacobs, A</b>  Telephone No. +49 89 2399 2830



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/US00/01362

**I. Basis of the report**

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).):*

**Description, pages:**

2-22 as originally filed

1,1i as received on 11/01/2001 with letter of 08/01/2001

**Claims, No.:**

1-44 as received on 11/01/2001 with letter of 08/01/2001

**Drawings, sheets:**

1/12,2/12,  
4/12-12/12 as originally filed

3/12 as received on 11/01/2001 with letter of 08/01/2001

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item:

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

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4. The amendments have resulted in the cancellation of:

- ☐ the description,      pages:  
☐ the claims,      Nos.:  
☐ the drawings,      sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes:	Claims	1-44
	No:	Claims	
Inventive step (IS)	Yes:	Claims	7-10, 17, 29, 30, 34, 40-44
	No:	Claims	1-6, 11-16, 18-28, 31-33, 35-39
Industrial applicability (IA)	Yes:	Claims	1-44
	No:	Claims	

2. Citations and explanations  
**see separate sheet**

**VI. Certain documents cited**

1. Certain published documents (Rule 70.10)

and / or

2. Non-written disclosures (Rule 70.9)

**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**VIII. Certain observations on the international application**

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The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:  
**see separate sheet**

**Re Item I**

**Basis of the report**

The amendments filed with the letter dated 8 January 2001 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following:

1. **Claim 31:** Feature d), which has been added to originally filed claim 34, pertains to retroreflecting light incident upon the fill layer, and has nothing to do with the "method for forming retroreflective sheeting" of original claim 34; further, no basis for this amendment can be found in the original application, for which reason this feature will be disregarded. As a precaution against infringing Article 34(2)(b) PCT by broadening the scope of the claim, however, amended claim 31 will be interpreted as if the term "open-faced" were reinserted (see p. 27, l. 6: "forming a plurality of open-faced cube-corner ..."), since the claim would otherwise not give any indication of the particular kind of retroreflective sheeting being referred to.
2. **Claim 39:** As a precaution against infringing Article 34(2)(b) PCT, the term "open-faced" is reinserted (in lines 9, 16, 20 of page 28), since the amended claim would otherwise not give any indication of the particular kind of retroreflective sheeting.
3. **Claim 40:** As in claims 31 and 39 above, as a precaution against infringing Article 34(2)(b) PCT, the term "open-faced" is reinserted (p. 28, line 23).

**Re Item VIII**

**Certain observations on the international application**

The independent claims of the international application, **claims 1, 23, 29, 31, and 39** do not fulfil the requirements of **Article 6 PCT**, the reasons therefor being:

1. Although **claims 1, 23 and 29** have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is

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EXAMINATION REPORT - SEPARATE SHEET**

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sought and/or in respect of slight variations of features of that subject-matter. The aforementioned claims therefore lack **conciseness**. Moreover, lack of clarity of the claims as a whole arises, since the plurality of independent claims makes it difficult, if not impossible, to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection.

The relevant subject-matter should be defined in terms of a **single independent claim** followed by dependent claims covering features which are merely optional (Rule 6.4 PCT).

2. The same remark as under 1. holds for **claims 31 and 39**.
3. **Claim 26**, dependent on claim 23, defines that the "cube-corner structures are formed on a carrier substrate"; however amended claim 23 already defines a carrier substrate, on which cube-corners are formed.  
A similar remark is valid regarding **claim 21**, which comprises all the features of claim 1.

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the documents cited in the international search report, in particular to:  
D1: US 4 127 693 A (LEMELSON JEROME H) 28 November 1978  
D2: US 5 657 162 A (NILSEN ROBERT B ET AL) 12 August 1997

Further, the following documents are referred to:

- D6: US 5 642 222 A (PHILLIPS EDWARD D) 24 June 1997  
D7: US 5 780 140 A (NILSEN ROBERT B) 14 July 1998  
D8: US 5 376 431 A (ROWLAND WILLIAM P) 27 December 1994  
D9: EP 0 525 708 A (CALUORI HANS-JÜRG ET AL) 3 February 1993

2. The retroreflective sheeting of **claim 1** is not inventive within the meaning of Article 33(3) PCT, the reasons therefor being:

2.1 **D1** (see Fig. 2, and col. 3, l. 55 - col. 4, l. 26) discloses a retroreflective sheeting ("sheet material": col. 2, l. 7), comprising:

- \* a plurality of cube-corner structures

("plurality of cavities {"indentations": col. 5, l. 17} 25 of pyramidal shape each of which cavities has side walls comprising three or more triangular shaped surfaces 25S and configured to define respective retro-reflecting formations": col. 3, l. 59-63; see also col. 2, l. 8-9: "sheet having a plurality of pyramidally shaped cavities therein defining corner reflectors")

formed from a substantially rigid material to keep the cube-corner structures from flexing

(see abstract: plurality of cube-corner surfaces can be made from glass, which doubtlessly prevents them from flexing);

- \* an optical coating formed on the structures

("surfaces 25S ... are ... metallized so as to provide suitable reflection of light directed thereagainst": col. 3, l. 63-65; see also col. 4, l. 18-23); and

- \* a fill layer covering at least a portion of the optical coating

("surfaces 25S ... and the rear surface 29 of the layer 26 are in surface abutment with each other": col. 4, l. 6-8),

wherein the optical coating retroreflects light incident upon the fill layer

(see fig. 2: see arrows; "retro-reflecting light directed into the cavity back to the vicinity of the source along respective paths which are parallel to the incident light": col. 4, l. 16-18).

2.2 Compared to the sheeting of **D1**, the sheeting of **claim 1** in addition merely stipulates a carrier substrate, on which said cube-corner structures are formed. Carrier substrates, carrier sheets and the like, on which the cube-corner structures of retroreflective sheeting are formed are, however, considered to be absolutely common features in the field of retroreflective sheeting; this view is corroborated eg. by the disclosure in **D2** (see col. 2, l. 28-31, see also "carrier sheet" 12, "flexible body member" 10 in figs. 1 and 2, on which microprisms 26 are formed). See also **D7** (col. 1, l. 28-31, and fig. 1), which describes "typical



prior art retroreflective sheeting" with cube-corner prisms on the carrier film 2; see also D8, figs. 2, 3, or 5, and col. 3, l. 19-22: "The sheeting 8 is conveniently formed by casting a resin formulation to form closely spaced microprisms 12 on a base film 10 ..." (NB: the microprisms can be of cube-corner type, see col. 1, l. 24-25, or clear from the figures).

- 2.3 Since the carrier substrate represents a feature of such standard type in the forming of a retroreflective sheeting and thus in the finished product, no inventive step can be attributed to a product comprising a combination of the sheeting of D1 with the feature of a carrier substrate. Therefore, the retroreflective sheeting of claim 1 does not fulfil the requirement of inventive step.
3. **Claim 23** differs from claim 1 only in terminology (see Item VIII); having regard to section 2. above, the retroreflective sheeting of **claim 23** is therefore not considered inventive within the meaning of Article 33(3) PCT.
4. The method for forming retroreflective sheeting of **claim 31** – see Item I – is not inventive, since this claim merely restates the features of the sheeting of claim 1 as steps of a process, and the latter claim is not considered to fulfil the requirement of inventive step.
5. **Claim 39** (see Item I):  
**D1** (see in particular col. 4, l. 1-11, l. 18-23) discloses
- \* forming a mold (see col. 4, l. 9-11) to form a plurality of prisms, each prism having a base and three intersecting lateral faces which meet at an apex (see also above under Section 2.1);
  - \* forming the retroreflective sheeting on the mold to form a mirror image of the mold wherein the resulting sheeting includes a plurality of three-sided indentations which form cube-corner structures  
(by using the covering layer 26 as a mold: "molding ... one in situ against the other": col. 4, l. 10-11),  
the cube-corner structures being formed from a substantially rigid material to keep

the cube-corners from flexing

(see abstract: plurality of cube-corner surfaces can be made from glass, which doubtlessly prevents them from flexing);

- \* coating the cube-corner structures with an optical coating (col. 4, l. 18-21); and
- \* covering at least a portion of the optical coating with a fill layer (covering layer 26).

D1 also implicitly discloses that the mold is formed by forming three sets of grooves, the grooves intersecting at an angle.

The only remaining difference between the sheeting of claim 39 and that of D1 lies in depositing the cube-corner structures on a carrier substrate. For the reasons stated above under section 2., this does not render the subject-matter of claim 39 inventive.

N.B: Attention is also drawn to the disclosure in D2, in particular concerning the forming of grooves, see col. 2, l. 35-44.

7. Dependent claims 2-6, 11-16, 18-22, 24-28, 32, 33, 35-38 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of Article 33(3) PCT, the reasons being as follows:
  - 7.1 **Claim 2:** see metallized facet sides of D6: col. 4, l. 47-48 (also note col. 4, l. 35-36).
  - 7.2 **Claims 3 and 4:** The choice of refractive index does not appear to represent a feature which in combination with the features of the parent claim would involve an inventive step.
  - 7.3 **Claims 5 and 6:** Thermoplastic and thermoset polymers are known eg. from D2, see col. 3, l. 12 in combination with col. 2, l. 41-44. Additionally, the polyurethane which can be used for the rigid array of retroreflective prism elements in D6 (see claim 4) is regarded as a thermoplastic material, which can be combined with another polymer (claim 5 of D6).

- 7.4 **Claim 11:** Voids enclosed by cube-corner surfaces are known from Fig. 3 of D1 (pyramidal cavities 33).
- 7.5 **Claim 12:** Colour coatings form part of the state of the art, see eg. D2: col. 1, l. 44-48, or col. 2, l. 50-55.
- 7.6 **Claim 13:** Fill layers that are transparent are known to the skilled person, as is clear from D1: transparent material 26 in Fig. 2.
- 7.7 **Claims 14 and 25:** A top coat of this kind, ie. covering a fill coat, is known from D2 (Fig. 3: 36 covers the fill coat 38, see also col. 2, l. 51-54).
- 7.8 **Claims 15, 24:** The fill layer 26 of D1 (embodiment of Fig. 2) can be made of polyvinyl chloride (see col. 5, l. 42-43 in combination with l. 18-20), which has an index of refraction of between 1.54 and 1.56 (col. 3, l. 49-50).
- 7.9 **Claim 16:** The choice of a certain application viscosity for the fill layer appears to relate to a standard feature in the art.
- 7.10 **Claims 18 and 27:** A retroreflector with more than one layer of cube-corner surfaces is also disclosed in Fig. 5 of D2, so that the provision of a double layer is not regarded as involving an inventive step. N.B.: In the case of "open-faced" cube-corners, it is moreover inevitable that the surfaces should face away from each other, and no unexpected effect is thereby achieved.
- 7.11 **Claim 19:** The sheeting of D6 can likewise be broken (embodiment of Fig. 1, "crack and split": col. 4, l. 7).
- 7.12 **Claims 20 and 28:** See 23B in Fig. 2 of D1, also col. 4, l. 23-26.
- 7.13 **Claim 21** (see Item VIII): The first additional feature is known (see comment concerning claim 26 below). The walls mentioned in the second feature appear to be the direct result of the provision of patterns, the thickness of these walls is moreover chosen from such a wide range that no inventive step seems to be involved.

7.14 **Claim 22:** It is well known to use retroreflecting sheets for projection screens.

7.15 **Claim 26** (see Item VIII): Carrier substrates, carrier sheets and the like are common features in retroreflective sheeting, see eg. D2: col. 2, l. 28-31. See also Section 2.2 and 2.3 above.

7.16 **Claims 32, 35, 36 and 37** are mere transfers of the respective entity claims 18, 14, 12, 16 into process or method claims, therefore reference is made to the comments above. A similar remark applies to **claim 38**.

7.17 **Claim 33:** Most prior art cube-corner retroreflectors have an uninterrupted, ie. a "continuously formed" array of cube-corners on the carrier sheet or any similar layer.

\*\*\*\*\*

8. **Claims 7-10** of the application relate to a retroreflective sheeting as defined in claim 1, wherein the fill layer is an electrooptically active composition. No such sheeting is described in the prior art on file.

9. **Claim 29:**

**D1** (see embodiment of Fig. 2, see also col. 5, l. 11-48) discloses the following:

- \* a polymer structure (polyvinyl chloride: col. 5, l. 19-20) having a plurality of cube-corner structures formed therein

- (see above: discussion concerning inventive step in the subject-matter of claim 1);

- \* a metal layer formed on the structures (see discussion of claim 1);

- \* a substantially transparent (col. 5, l. 29) fill layer covering at least a portion of the metal layer, the fill layer having a glass transition temperature in the range of between -20 and 80 degrees Celsius,

- (fill coat can consist of PVC: see col. 5, l. 42-43 in combination with l. 17-21;

- PVC has a glass transition temperature of approx. 80°C, see D9: p. 4, l. 55;

- NB: The basis for an amendment of the originally filed claim 32 is to be

found on p. 8, l. 19-21 of the application: "between about -20 and 80 degrees Celsius").

wherein the metal layer retroreflects light incident upon the fill layer (see discussion of claim 1).

Besides additionally providing a carrier substrate for the sheeting, claim 1 differs from the disclosure of D1 in defining that the cube-corner structures are formed from a substantially rigid material to keep the cube-corners from flexing.

Although D1 mentions glass structures, which are clearly rigid and prevent these from flexing, when in fact discussing the use of a polymer structure in which the cube-corners are formed, it does this in the context of using flexible material (see col. 5, l. 17-21, also l. 27-29), thus teaching away from a rigid polymer.

Document D6, on the other hand, describes rigid, polymeric prism elements (see in particular col. 3, l. 49-65), but does not deal with "open-faced" retroreflectors, ie the fill layer (elastomeric film 44, see figs. 2 and 3) covering the metal layer formed on the structure is not described as transparent.

The prior art surveyed in this examination would not in the end, however, appear to suggest that particular combination of features from the documents D1 and D6 leading to a sheeting according to claim 29.

**Claim 30** comprises all the features of claim 29.

10. **Claims 40-44** (as amended according to **Item I**) and **17** describe retroreflective particles as opposed to sheeting, **claim 34** the step of forming such particles; nowhere in the available prior art are such articles suggested or hinted at.

#### **Re Item VII**

#### **Certain defects in the international application**

Independent **claims 29 and 40** are not in the two-part form in accordance with Rule 6.3(b) PCT, with those features known in combination from the prior art being placed in

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the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

Although documents D1, D2 and D6 are acknowledged as prior art in the amended description, it is not made clear which features of the subject-matter of the independent claims presented in the application are known in combination from these respective documents (see PCT Guidelines, III-2.3a).

**Re Item VI**

**Certain documents cited**

Certain published documents (Rule 70.10 PCT):

Application No Patent No	Publication date (day/month/year)	Filing date (day/month/year)	Priority date (valid claim) (day/month/year)
PCT/US99/10347 (Int. Publ. No.: WO 00/42453)	20/July/2000	12/May/1999	11/January/1999
PCT/US99/10601 (Int. Publ. No.: WO 00/42454)	20/July/2000	13/May/1999	11/January/1999

Documents WO 00/42453 and WO 00/42454 each disclose subject-matter relevant to **claims 1, 23, 31 and 39** (claims 31 and 39: see Item I above) of the international application.

CLAIMS

What is claimed is:

1. Retroreflective sheeting (14), comprising:
  - 5 a) a carrier substrate (16);
  - b) a plurality of cube-corner structures (18) formed from a substantially rigid material to keep the cube-corner structures from flexing, the cube-corner structures being formed on the carrier substrate;
  - c) an optical coating (20) formed on the structures; and
  - 10 d) a fill layer (32) covering at least a portion of the optical coating, wherein the optical coating retroreflects light incident upon the fill layer.
2. The sheeting of claim 1, wherein the optical coating (20) includes a specular coating.
- 15 3. The sheeting of claim 1, wherein the optical coating (20) includes a low index of refraction dielectric material.
4. The sheeting of claim 3, wherein the index of refraction is in the range of between about 1.1 and 1.3.
5. The sheeting of claim 1, wherein the substantially rigid material is selected  
20 from a group consisting of thermoplastic and thermoset polymers.
6. The sheeting of claim 5, wherein the polymers further include a filler which is selected from a group consisting of glass, graphite, polymers, and metals.
7. The sheeting of claim 1, wherein the fill layer is an electrooptically active composition.

8. The sheeting of claim 7, further including a top carrier sheet (38) above the fill layer (32), the top carrier sheet being conductive for allowing an electrical charge to pass between the top carrier sheet and the optical coating (20).
- 5 9. The sheeting of claim 8, wherein the top carrier sheet (38) includes a transistor pattern.
- 10 10. The sheeting of claim 7, further including a top carrier sheet (38) above the fill layer, the top carrier sheet being conductive, and a bottom carrier sheet (16) under the cube-corner structures, the bottom carrier sheet also being conductive for allowing an electrical charge to pass between the top carrier sheet and the bottom carrier sheet.
- 15 11. The sheeting of claim 1, wherein a plurality of voids (24) form the cube-corner structures (18) and wherein each void includes three surfaces which meet at a nadir.
12. The sheeting of claim 1, further comprising a color coating (42) on at least some of the structures.
- 20 13. The sheeting of claim 1, wherein the fill layer (32) is substantially transparent.
14. The sheeting of claim 13, further comprising a top coat (48) covering the fill layer.
15. The sheeting of claim 13, wherein the fill layer (32) has an index of refraction in the range of between about 1.5 and 1.65.
- 25 16. The sheeting of claim 1, wherein the fill layer (32) has an application viscosity less than or equal to 1,000 centipoise.



17. The sheeting of claim 1, wherein the sheeting is formed into particles (50).
18. The sheeting of claim 1, wherein a second layer of retroreflective cube-corner structures (18) is formed on a back side of the carrier substrate (16) such that a first layer of retroreflective cube-corner structures and the second  
5 layer of retroreflective cube-corner structures are back to back with respective surfaces facing away from each other.
19. The sheeting of claim 18, wherein the carrier substrate is breakable into particles (50) having back to back retroreflective sheetings thereon.
- 10 20. The sheeting of claim 1, further comprising patterns (24) on the retroreflective sheeting (14) having no cube-corner structures (18).
21. The sheeting of claim 20, wherein:  
the cube-corner structures (18) are formed on a carrier substrate (16);  
and  
15 the patterns form walls in the retroreflective sheeting that extend from the carrier substrate to a prism ridge, the thickness of the walls being in the range of between about 25.4 and 1,270 micrometers (0.001 and 0.05 inches).
22. A projection screen (84) which includes the retroreflective sheeting of  
20 claim 1.
23. Retroreflective sheeting (14), comprising:
  - a) a carrier substrate (16);
  - b) a plurality of three-sided indentations which form cube-corners, the cube-corners being formed from a substantially rigid material to keep  
25 the cube-corners from flexing, the cube-corners being formed on the carrier substrate;
  - c) a reflective coating (20) formed on the three-sided indentations; and

- d) a fill layer (32) covering at least a portion of the reflective coating, wherein the optical coating retroreflects light incident upon the fill layer.
- 5    24. The sheeting of claim 23, wherein the fill layer (32) has an index of refraction in the range of between about 1.5 and 1.65.
25. The sheeting of claim 23, further comprising a top coat (48) covering the fill layer (32).
26. The sheeting of claim 23, wherein the cube-corner structures (18) are formed  
10 on a carrier substrate (16).
27. The sheeting of claim 26, wherein a second layer of retroreflective cube-corner structures is formed on a back side of the carrier substrate (16) such that a first layer of cube-corner surfaces and the second layer of retroreflective cube-corner structures are back to back with respective  
15 surfaces facing away from each other.
28. The sheeting of claim 23, further comprising patterns (24) in the retroreflective sheeting (14) having no cube-corners.
29. Retroreflective sheeting (14), comprising:
- a) a carrier substrate (18);
  - 20 b) a polymer structure (18) having a plurality of cube-corner structures formed therein, the cube-corner structures being formed from a substantially rigid material to keep the cube-corners from flexing, the cube-corner structures being formed on the carrier substrates;
  - c) a metal layer formed on the structures; and
  - 25 d) a substantially transparent fill layer (32) covering at least a portion of the metal layer, the fill layer having a glass transition temperature in

the range of between -20 and 80 degrees Celsius, wherein the metal layer retroreflects light incident upon the fill layer.

30. The sheeting of claim 29, wherein the fill layer has an index of refraction in the range of between about 1.5 and 1.65.
- 5 31. A method for forming retroreflective sheeting (14), comprising:
- a) forming a plurality of cube-corner structures (18) from a substantially rigid material to keep the cube-corner structures from flexing, the structures being formed on a carrier film (16);
  - b) forming a specular coating (30) on the structures;
  - 10 c) attaching a fill layer (32) to at least a portion of the specular coating; and
  - d) retroreflecting light incident upon the fill layer with the specular coating.
- 15 32. The method of claim 31, further comprising the step of forming a second layer of retroreflective cube-corner structures (18) on a back side of the carrier film (16) such that a first layer of retroreflective cube-corner structures and the second layer of retroreflective cube-corner structures are back to back with respective surfaces facing away from each other.
- 20 33. The method of claim 31, further comprising the step of continuously forming the cube-corner structures (18) on the carrier film (16).
34. The method of claim 31, further comprising the step of forming the sheeting into particles (50).
35. The method of claim 31, further comprising the step of forming a top coat (48) over the fill layer (32).

36. The method of claim 31, further comprising the step of forming a color coating (46) on at least some of the structures.
37. The method of claim 31, wherein the fill layer (32) comprises a material with an application viscosity of less than or equal to about 1,000 centipoise.
- 5 38. The method of claim 31, further comprising the step of forming the cube-corner structures on a back side of traditional retroreflective sheeting (14) having cube-corner prisms, the cube-corner structures and the cube-corner prisms facing away from each other.
39. A method for forming retroreflective sheeting (14), comprising:
- 10 a) forming a mold by forming three sets of grooves, the grooves intersecting at an angle to form a plurality of prisms, each prism having a base and three intersecting lateral faces (18) which meet at an apex;
- 15 b) forming the retroreflective sheeting on the mold to form a mirror image of the mold wherein the resulting sheeting includes a plurality of three-sided indentations which form cube-corner structures, the cube-corner structures being formed from a substantially rigid material to keep the cube-corners from flexing;
- 20 c) depositing the cube-corner structures on a carrier substrate (16);
- d) coating the cube-corner structures with an optical coating (20); and
- e) covering at least a portion of the optical coating with a fill layer (32).
40. Retroreflective particles (50) comprising cube-corner structures having an optical coating (20) thereon, the cube-corner structures being formed from a
- 25 substantially rigid material to keep the cube-corners from flexing.
41. The retroreflective particles of claim 40, further comprising second cube-corner structures having specular coating (20) thereon laminated to a back

side of the first cube-corner structures such that respective surfaces face away from each other.

- 5      42.      The retroreflective particles of claim 40, further comprising a color coating (46) on at least some of the structures.
43.      The retroreflective particles of claim 40, further comprising a fill layer (32) attached to at least a portion of the optical coating (20), the fill layer having an index of refraction in the range of between about 1.5 and 1.65.
- 10      44.      The retroreflective particles of claim 40, wherein the cube-corner structures (18) include different size structures on the particles (50).

## DURABLE, OPEN-FACED RETROREFLECTIVE PRISMATIC CONSTRUCTION

### BACKGROUND OF THE INVENTION

5        Traditional retroreflective sheeting materials, such as those disclosed in U.S. Patents 3,689,346, 3,712,706, and 3,810,804, the teachings of which are incorporated herein by reference, are described as cube-corner structures that are molded from tooling that comprises of a plurality of element forming cavities (odd generation tooling) which produce cube-corner segments having substantially planar  
10   front major surfaces.

      Traditional cube-corner prisms have a base with three surfaces intercepting at an apex. As shown in Figure 1, the prisms are oriented such that the light ray R enters through the base 10 and is retroreflected by the three surfaces 12. This requires that the prisms be formed from a material which allows a significant  
15   amount of the light rays to pass therethrough. Thus, the prism material is limited to materials which have this property. Unfortunately, it has been found that these materials are often susceptible to ultraviolet (UV) light, visible light, and/or thermal degradation, resulting in diminished performance capabilities.

      U.S. Patent 4,127,963, issued on November 28, 1978 to Lemelson, discloses  
20   structures, which are molded, extruded, or embossed plastic or glass which is formed with a plurality of irregular surface formations such as cavities, short or elongated protrusions defining irregular surface formations in or against which dirt or dust may collect and form light blocking material which substantially reduces the efficiency of the reflector or display.

U.S. Patent 5,657,162, issued on August 12, 1997 to Nilsen *et al.*, discloses a formation of retroreflective sheeting and articles in which the size of the retroreflective and non-retroreflective surfaces may be varied across an array of microprisms.

- 5 U.S. Patent 5,642,222, issued on June 24, 1997 to Phillips, discloses a retroreflective structure having prism elements and a method for making the structure.

#### SUMMARY OF THE INVENTION

- 10 Retroreflective sheeting and a method for making the same includes a plurality of open-faced cube-corner surfaces formed from a substantially rigid material to keep the cube-corner surfaces from flexing. An optical coating is formed on the surfaces and a fill layer is attached to at least a portion of the optical coating. Preferably, a plurality of voids form the open-faced cube-corner surfaces, wherein each void includes three surfaces which meet at a nadir.

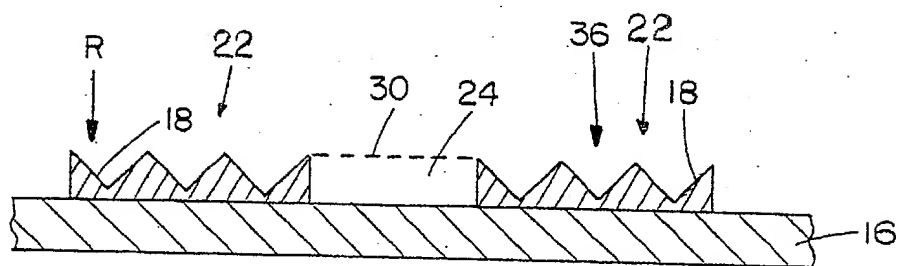


FIG. 5

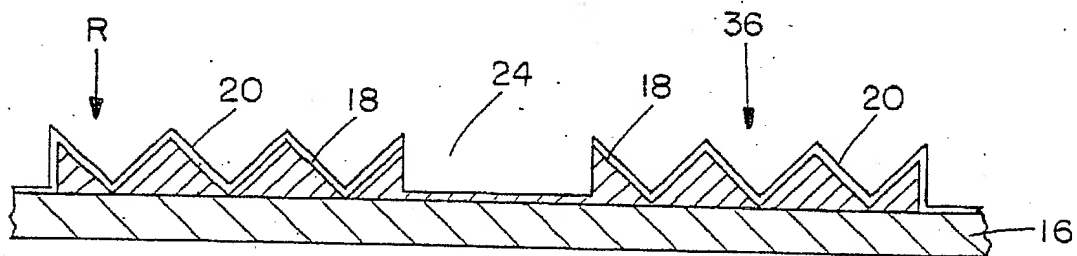


FIG. 6

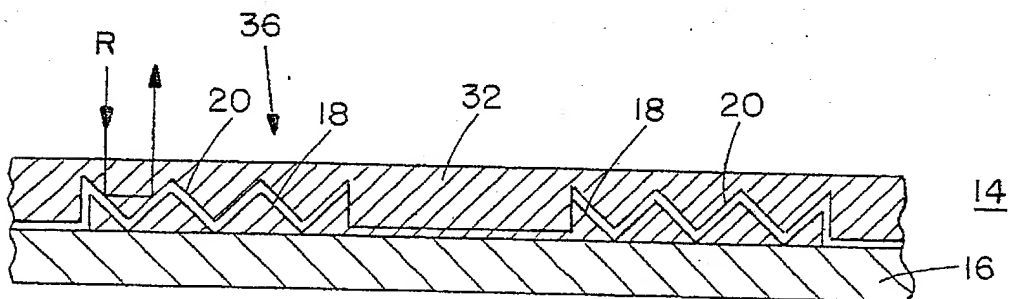


FIG. 7

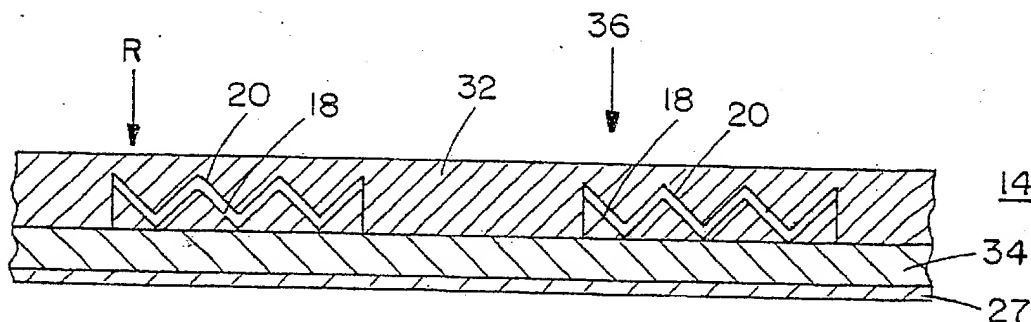


FIG. 8



From the INTERNATIONAL SEARCHING AUTHORITY

**PCT**NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL SEARCH REPORT  
OR THE DECLARATION

(PCT Rule 44.1)

To:

HAMILTON, BROOK, SMITH &  
REYNOLDS, P.C.  
Attn. CONWAY, R.  
Two Militia Drive  
Lexington, MA 02421  
UNITED STATES OF AMERICADate of mailing  
(day/month/year)

11/04/2000

Applicant's or agent's file reference

1571.1144003

**FOR FURTHER ACTION**

See paragraphs 1 and 4 below

International application No.

PCT/US 00/ 01362

International filing date

(day/month/year)

20/01/2000

Applicant

REFLEXITE CORPORATION

- 1.
- ☒
- The applicant is hereby notified that the International Search Report has been established and is transmitted herewith.

**Filing of amendments and statement under Article 19:**

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

**When?** The time limit for filing such amendments is normally 2 months from the date of transmittal of the International Search Report; however, for more details, see the notes on the accompanying sheet.**Where?** Directly to the International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland  
Facsimile No.: (41-22) 740.14.35

FOREIGN DOCKETING

11 04 00 - S O U

Initial

For more detailed instructions, see the notes on the accompanying sheet.

Update Foreign Case Card

Update Foreign Filing Record

- 2.
- ☐
- The applicant is hereby notified that no International Search Report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

ANNUITY DOCKETING

- 3.
- ☐
- With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

- 4.
- Further action(s):**
- The applicant is reminded of the following:

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the International Searching Authority

European Patent Office, P.B. 5818 Patentlaan 2  
NL-2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Marie-Françoise Provot

## PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>1571.1144003</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/US 00/ 01362</b>	International filing date (day/month/year) <b>20/01/2000</b>	(Earliest) Priority Date (day/month/year) <b>21/01/1999</b>
Applicant  <b>REFLEXITE CORPORATION</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

## 1. Basis of the report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (see Box II).

## 4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

## 5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

2  
☐ None of the figures.

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 G02B5/124 H05B33/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 G02B H05B E01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 127 693 A (LEMELSON JEROME H) 28 November 1978 (1978-11-28)  column 3, line 55 -column 6, line 12; figures 2,3	1-6, 11-19, 24-29, 32-35,43
A	US 5 657 162 A (NILSEN ROBERT B ET AL) 12 August 1997 (1997-08-12) column 2, line 26 -column 5, line 60; figures 2-6	1-48
A	WO 98 53645 A (ABE HIDETOSHI ;ARAKI YOSHINORI (JP); MINNESOTA MINING & MFG (US)) 26 November 1998 (1998-11-26) page 4, line 13 -page 13, line 23; figure 1  -/-	1-48

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

4 April 2000

Date of mailing of the international search report

11/04/2000

Name and mailing address of the ISA

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Fax: (+31-70) 340-3018

Authorized officer

THEOPISTOU, P

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 20375 A (MINNESOTA MINING & MFG) 14 May 1998 (1998-05-14) figures 1,2; examples 1,2 -----	1-48
A	US 4 208 090 A (HEENAN SIDNEY A) 17 June 1980 (1980-06-17) column 3, line 51 -column 8, line 3; figures 4-8 -----	1-48

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